ARS 73-21
October 1958

Frozen High-Density Fresh-Flavor Peach Concentrates

BY A CONTINUOUS PROCESS

Agricultural Research Service
U. S. DEPARTMENT OF AGRICULTURE

ABSTRACT

Frozen peach concentrates, retaining the characteristic fresh flavor of the fruit, have been prepared by a continuous process. The products and their proposed end-uses are:

1. A seven-fold puree concentrate for enhancing peach ice cream flavor.

2. A four-fold nectar concentrate for beverage use.

Processing consists of pitting, peeling, pureeing, inactivating the enzyme, depectinizing, separating juice and fiber, simultaneously recovering the aroma and concentrating the juice, restoring aroma and fibers to the juice concentrate, homogenizing, canning and freezing. Requirements are given for a commercial installation capable of processing 600 gallons per hour of single-strength puree to seven-fold puree concentrate.

This is a report of work done at the

EASTERN UTILIZATION RESEARCH AND DEVELOPMENT DIVISION

Philadelphia 18, Pa.

FROZEN HIGH-DENSITY FRESH-FLAVOR PEACH CONCENTRATES BY A CONTINUOUS PROCESS

by

Nelson H. Eisenhardt, Nicholas C. Aceto, Joseph B. Claffey, and
Clifford S. Redfield

BACKGROUND

Peaches are the fourth most valuable domestic fruit crop and have an annual farm value of approximately 120 million dollars. Freestone varieties predominate east of the Rocky mountains and these are sold primarily for the fresh market and for home canning. The development of new processing outlets would aid in stabilizing the economy in areas that depend on fresh market sales and could absorb much of the surplus of sound culls that occurs in years of good yield. In South Carolina, for example, it is reported that 180,000 to 270,000 bushels of culls are graded out annually because of size or defects in appearance.

A fully ripe peach is a highly perishable commodity, which quickly loses its characteristic flavor owing to rapid enzymatic deterioration. New products, retaining the fresh peach flavor and in a relatively stable form have been developed by the Eastern Utilization Research and Development Division. These products are: (1) a frozen unsweetened whole puree concentrate, seven-fold with respect to single strength puree, for enhancing peach ice cream flavor; and (2) a frozen sweetened nectar concentrate, four-fold on a 15° Brix beverage basis. The term "fold" refers to volumetric concentration, e.g. "seven-fold" means that with respect to the concentrate, the single strength puree has 7 times the volume.

Techniques for the production of these concentrates are described in this paper.

PROCESSING SUMMARY

Modern fruit concentrate processing requires a continuous, rapid throughput system yielding an economical, high quality product. To accomplish this for peach, a continuous process has been developed with only the minimum exposure to flavor damaging temperatures.

The key to the preservation of fresh flavor in the concentrates is in the rapid inactivation of the natural occurring enzymes early in the process and in volatile flavor recovery during concentration. A high solids content in the concentrates is achieved by separating the juice from fibrous material, concentrating the juice, then restoring the fibers to yield the desired product. consistency.

Briefly, processing consists of pitting, peeling, pureeing, inactivating the enzyme, depectinizing, separating juice and fiber, simultaneously recovering the aroma and concentrating the juice, restoring aroma and fibers to the juice concentrate, homogenizing, canning, and freezing. These steps are shown in the flow chart, Figure 1.

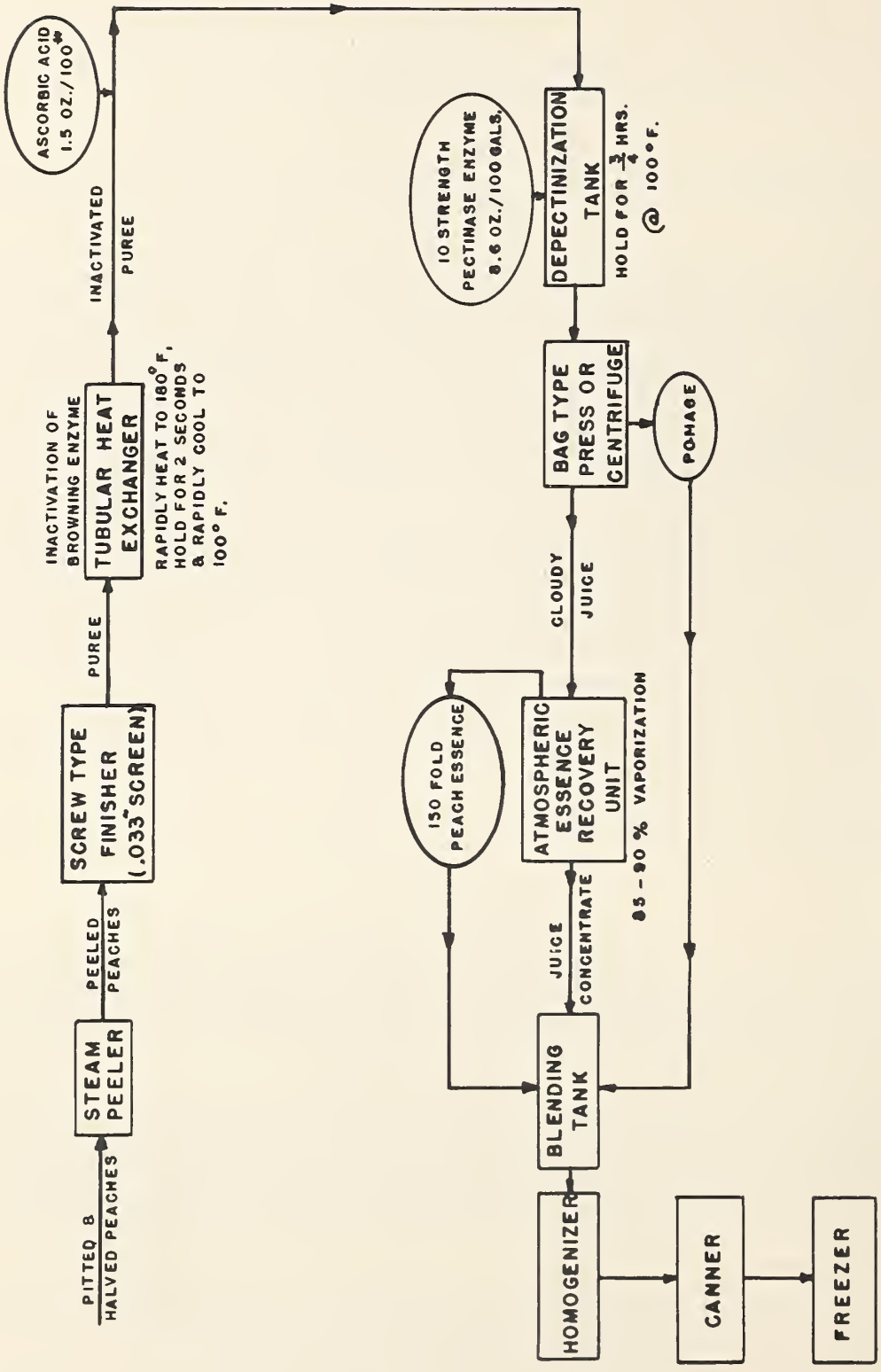

FIGURE 1
Schematic Diagram for Peach Processing

EXPERIMENTAL PROCESSING STEPS

Preparation of Puree: Since the product can be only as good as the starting material, it is essential that sound, mature peaches are used. Maturity equivalent to that required of frozen slices has been found satisfactory. There are several commercially acceptable methods used for peeling peaches, such as steam, lye, and acid peeling (5, 9)*. Steam peeling was used in this process. Whole peaches were halved and pitted by hand, then the halves were placed skin side up on a continuous conveyor where they were subjected to steam at atmospheric pressure for approximately 1 minute. Halves were cooled with a water spray, and the skins slipped off by hand. The peeled peaches were immediately pureed in a Chisolm-Ryder ** cylindrical juice extractor having an 0.033" screen with end clearances of 0.030" or less. The discharge was modified to combine the tailings with the material passing through the screen. In this manner all of the peach was recovered.

Puree Inactivation and Depectinization: Elimination of rapid browning due to enzymatic action is of primary importance in stabilizing the puree. A method for inactivating polyphenolase by rapid heat treatment of the puree was described by Western Utilization Research and Development Division workers (2). Similar treatment was given the puree by using two Votators in series with a holding coil between. The puree was heated rapidly to 180° F. (82° C.) held for two seconds in the coil, then cooled quickly to 100° F. (37.8° C.). Residual activity of polyphenolase was 0.1% or less as determined by the method of Ponting and Joslyn (7) and as modified by Dimick et al. (2). Inactivated puree retained the fresh quality of the fruit, and showed no sign of enzymatic browning after 2 days storage at room temperature in contact with air.

Puree leaving the cooling Votator* at 100° F. (37.8° C.) was treated with Rohm and Haas Pectinol 10M (8.6 oz./100 gal. of puree) for 3/4 hour. Depectinization facilitated juice-fiber separation and permitted high juice concentration to be achieved without gel formation.

L-ascorbic acid was added (1.5 oz./100 lb. of puree) during depectinization to prevent normal oxidative browning, which occurs at a greatly reduced rate in the inactivated puree. Also the addition of Vitamin C places the nectar type concentrate on a comparable level with other beverages that are rich in this natural occurring vitamin.

* Numbers in parentheses refer to Literature cited at end of report.

** Mention of specific manufacturers, or products in this publication, does not imply endorsement by the Department of Agriculture over others not mentioned.

Juice-Fiber Separation: Concentration of puree by conventional means is limited to about three-fold. The presence of fibers in the juice increases the apparent viscosity of the concentrate, thereby making further concentration difficult. Hence, removal of fibers from the juice was necessary to achieve the desired degree of concentration in the products.

Separation of the two components was done satisfactorily with either a Harris bag press or a Sharples Super Centrifuge. The fibrous material, or pomace, was held for blending with essence and juice concentrate later in the process.

Flavor Recovery and Juice Concentration: The volatile flavoring constituents contained in the expressed juice were removed in an essence recovery unit (1,4,6). The manufacture and use of volatile fruit concentrates are subject to regulations of the Internal Revenue Service (8). Normally, 45% by volume would be vaporized for flavor recovery, and the juice, stripped of aromas, would be concentrated by vacuum evaporation. However, it was practicable to recover the essence and concentrate the juice simultaneously in the essence unit. This was done by stripping as much as 90% by volume of the juice and fractionating the evolved vapors. No flavor damage to the products was observed by taste panel members. The single pass atmospheric concentration technique has been described by Eskew et al. (3).

The processing steps that have been described were common to both products. Subsequent steps required for preparing the two products were as follows:

Puree Concentrate: Unsweetened juice concentrate was produced simultaneously with the volatile aromas in an essence recovery unit. All of the pomace recovered from the juice extraction operation together with the recovered volatiles were blended with the concentrate, and the mixture was then homogenized to a smooth consistency. The puree concentrate was made seven-fold by volume with respect to the single strength puree. The degree of concentration of the juice is dependent upon the desired fold of the finished product and the moisture (juice) content of the pomace. In these experiments pomace moisture averaged 65%. The amount of moisture, as juice, retained in the pomace should be as low as practicable, because of its dilution effect when added to the concentrate. Obviously the lower the pomace moisture the lesser the degree of concentration required.

This concentrate is intended primarily for use in increasing the level of flavor in peach ice cream. The obvious advantage of the concentrate over fresh peaches is that more flavor can be introduced into ice cream with minimum dilution.

A commercial scale process, with cost estimates, for making puree concentrate is described later.

Beverage Nectar: An acceptable sweetness in the nectar was obtained by altering the Brix-acid ratio of the concentrate. Sucrose, equal to 93% by weight of the soluble solids in the juice, was added prior to volatile flavor recovery; the increased Brix of the feed juice also resulted in a reduced vaporization required to achieve the desired concentration in a single pass. The degree of concentration is dependent upon the quantity of addback pomace

and its moisture content. In determining the amount of pomace addback, the effect of seasonal variation of the insoluble solids content of the peach must be taken into account. The desired nectar consistency was obtained one year by adding 100% of the recovered pomace; however, only 50% was required the following year. Taste panel members at the Eastern Utilization Research and Development Division considered the consistency of reconstituted nectar to be satisfactory if the apparent viscosity was between 95-120 centipoises as measured by a Brookfield viscosimeter (LVF spindle at 30 RPM, 74° F.) (23.3° C.). The desired amount of pomace added to the concentrate should be determined experimentally prior to establishing production conditions.

Sweetened concentrate, pomace, and recovered aromas were blended; then the mixture was homogenized for smoothness. The soluble solids content of the nectar concentrate was established at 51.4° Brix, so that dilution with three volumes of water resulted in a 15° Brix beverage. The chilled beverage was considered to be a very palatable drink having a fresh peach flavor and a natural color.

COMMERCIAL APPLICATION

The preparation of full-flavor puree concentrate is discussed here to show the application of experimental techniques to commercial scale operation. It is assumed that the plant will be operated in conjunction with a sliced peach freezing plant with facilities available to pit and peel 138 bushels per hour of fresh peaches. This quantity will supply the 600 gallons per hour of puree required for processing. The plant will operate 10 hours a day for 60 days each year. Figure 2 is a flow sheet of the whole peach puree concentrate process, and the numbers refer to items of equipment described in Table I. Peeled and pitted peach halves from (No. 1) are pureed in the juicer (No. 2), then pumped (No. 3) to the inactivator. Heating to 180° F. (80° C.) in the inactivation step and subsequent cooling to 100° F. (37.8° C.) are done rapidly in heat exchangers (No. 4) and (No. 5).

The puree goes to tank (No. 6) for depectinization. Three 525-gallon tanks with agitators are required; each operating on a cycle of 2-1/4 hours for filling, depectinization, and emptying. 2.42 pounds of Rohm and Haas Pectinol 10M and 3.7 pounds of l-ascorbic acid are charged to each tank after filling. Depectinized puree is pumped (No. 7) to a continuous centrifuge (No. 8), with the liquid discharge going to tank (No. 12), and the solids discharge (No. 9) to a bag press (No. 10) for further juice extraction. This latter step is necessary to reduce the moisture content of the pomace to 60%. The subsequent degree of juice concentration is dependent upon this moisture content. Pomace is collected in tank (No. 11) for later addition to the concentrate. Juice discharge from the bag press goes to tank (No. 12) from which it is pumped (No. 13) at 564 GPH to the combination essence recovery unit and juice concentrator. Juice at 10° Brix is preheated in (No. 14) to 220° F. (104° C.), then 89% by volume is vaporized in (No. 15) resulting in a 69.6° Brix concentrate. Concentrate and vapors are separated in (No. 16) and the vapors are sent to a packed fractionating column (No. 17). The concentrate is pumped (No. 23) through cooler (No. 24) to a blending tank (No. 25). The volatile aromas are concentrated in the fractionating column to 150 times their strength in the juice feed, then condensed and cooled to 190° F. (88° C.) in a condenser (No. 18). Column reflux essence product and noncondensable gases are separated in the splitter (No. 19).

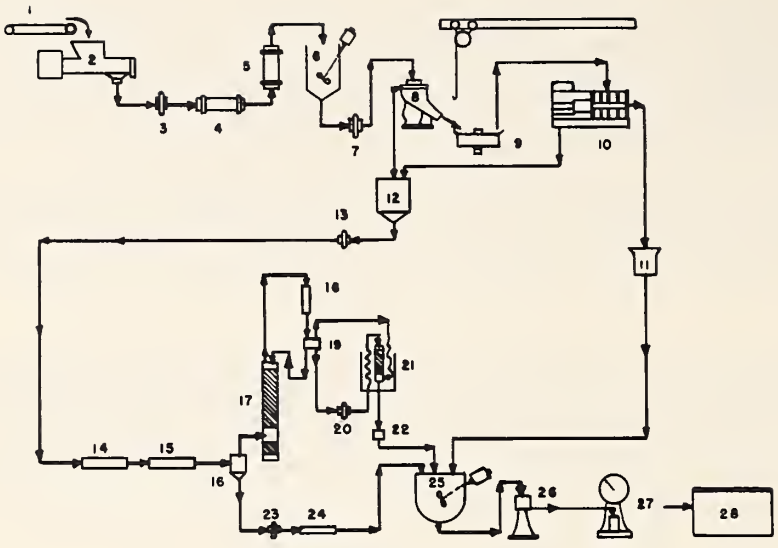

FIGURE 2
Flow Sheet for Whole Peach Puree Concentrate

TABLE I

Item	Description of Peach Puree Concentration Process Illustrated in Figure 2.
1	Conveyor for pitted and peeled peaches
2	Juice extractor, finisher, to prepare puree
3	Pump to feed puree to inactivator
4	Inactivator for heat inactivation of enzyme
5	Cooler to cool puree
6	Tanks, three required for continous depectinization
7	Pump, to transfer puree to centrifuge
8	Centrifuge, continous juice fiber separation
9	Containers to transfer solids from centrifuge
10	Bag press, final juice extraction
11	Containers to transfer solids from bag press
12	Surge tank for juice feed to essence recovery unit
13	Pump for juice feed
14	Preheater to heat juice to boiling point
15	Vaporizer to strip volatiles and concentrate juice
16	Liquid vapor separator
17	Fractionating column to concentrate volatiles
18	Condenser
19	Reflux splitter
20	Pump to withdraw essence
21	Scrubber to remove volatiles from noncondensable vent gases
22	Container for essence product
23	Pump to transfer juice concentrate
24	Cooler to cool concentrate
25	Tank for blending concentrate, essence and pomace
26	Homogenizer
27	Weighing and packaging product
28	Freezer

Essence is then pumped (No. 20) through a chilled packed column (No. 21), in which the vent gases are scrubbed. The effluent essence from the scrubber is collected in receiver (No. 22). Scrubbed gases are vented to the atmosphere.

Essence at 3.8 GPH, concentrate at 63 GPH, and pomace at 246 pounds per hour are blended in tank (No. 25, then fed to a homogenizer (No. 26). The homogenized full-flavor peach puree concentrate at 57.2° Brix is weighed into 30-pound enameled fruit tins (No. 27), then placed in frozen storage (No. 28).

In estimating the cost of preparing puree concentrate it is assumed that space to house the additional equipment is available, as is office equipment and freezer space. Increased boiler capacity as well as additional power facilities are included in the fixed capital cost.

Manpower to operate the concentrate plant would require 1 operator and 4 helpers in addition to the help normally needed to pit and peel the peaches.

The fixed capital required for this factory would be about $193,000 and working capital required would be about $152,000 for 30 days operation.

This plant will produce 874 gallons of product per day. The cost to make this product would be $5.79 per gallon or $0.57 per pound.

These costs include peaches at an average price of $1.60 per bushel, plus all other materials, labor, factory overhead, interest on working capital, and administrative and general expense. These costs also include a rent charge which is prorated against the already existing expenses of preparing frozen peach slices.

It is assumed in preparing these cost estimates that the plant would be located in an area where only peaches are available for processing. In other localities, however, modification of plant facilities would permit the processing of apple, grape, cherry, and berry juices. This would extend the overall plant operating season and thereby reduce overhead costs.

Advantages of the concentrate over frozen slices are: (a) decreased bulk resulting in lower storage and shipping costs for an equivalent amount of fruit, (b) the puree does not brown on thawing because enzymes have been inactivated, and (c) more flavor can be incorporated in the ice cream without excessive product dilution.

SUMMARY

Production of peach concentrates could serve as an outlet for sound culls and aid in stabilizing the market for processed peaches by preserving their fresh flavor in a low-bulk form.

Experimental methods are presented for the preparation of two types of concentrated peach products. Extrapolation of these methods to a continuous, commercial scale process for making whole puree concentrate is described and cost data included.

The key to the excellent flavor and color retention of these products is the rapid inactivation of the browning enzymes and the recovery of the volatile flavors that would normally be lost in concentrating the fruit. High puree concentrations are achieved by separating juice from the fibers in the puree, concentrating the juice, then mixing the concentrate with the fibers.

Modification of plant facilities for processing fruit juices other than peach is cited as a means of extending the plant operating season and thereby reducing overhead costs.

LITERATURE CITED

1. Claffey, J. B., Eskew, R. K., Eisenhardt, N. H., and Aceto, N. C. An Improved Experimental Unit for Recovery of Volatile Flavors. U. S. Dept. Agr., Agr. Res. Serv. ARS 73-19 (1958).

2. Dimick, K. P., Ponting, J. D., and Makower B. Heat Inactivation of Polyphenolase in Fruit Purees. Food Technology 5, 237 (1951).

3. Eskew, R.K., Claffey, J. B., Aceto, N. C., and Eisenhardt, N. H. Rapid Atmospheric Evaporator Simplifies Juice Concentration and Improves Flavor Recovery. To be published.

4. Eskew, R. K., Redfield, C. S., and Phillips, G. W. M. High Density, Full-Flavor Apple Juice Concentrate. U. S. Dept. Agr., Bur. Agr. and Indus. Chem. AIC-315 (1951).

5. Havighorst, C. R. New Machines and Techniques Cut Fruit Loss, Raise Quality. Food Eng. *28*, 5, 52 (1956).

6. Milleville, H. P., and Eskew, R. K. Recovery of Volatile Apple Flavors in Essence Form. Western Canner and Packer *38*, 51 (1946).

7. Ponting, J. D., and Joslyn, M. A. Ascorbic Acid Oxidation and Browning in Apple Tissue Extracts. Arch. Biochem. *19*, 47 (1948).

8. United States Code of Federal Regulations. Production of Volatile Fruit-Flavor Concentrates. In Title 26--Internal Revenue, 1954, Parts 170 to 220; Revised, 1956, pp 387-403, constituting Part 198 of Chapter I--Internal Revenue Service. (1957). (Supplemented by current regulatory material appearing in the Federal Register.)

9. Woodroof, J. O., Shelor, E., Cecil, S. R., and Atkinson, I. Preparation of Peaches for Freezing. Ga. Agr. Expt. Sta. Bulletin 251, April 1947.